2019

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## Citation Details

S. Zarrin and T. U. Daim, "Strategic Technology Planning in Product-Service Systems with Embedded Customer Experience Requirements," 2019 Portland International Conference on Management of Engineering and Technology (PICMET), Portland, OR, USA, 2019, pp. 1-9.

# Strategic Technology Planning in Product-Service Systems with Embedded Customer Experience Requirements

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*Abstract*—**The undeniable impact of Artificial Intelligence and Internet of things on value proposition and offerings of firms, drive many strategic initiatives in organizations to design solutions which integrate products and services. Since designing Product-Service Systems inherently introduce high level of complexity and adding artificial intelligence requirements as one of the influential factors overcomplicate the long-term planning processes, the strategic planners seek for effective tools to enable them to manage the level of complexity as well as empowering them to communicate the outcomes with the whole organization.**

**In order to achieve this purpose, Technology Roadmaps provides a structured and flexible means for designing product-service systems which can manage the advanced technologies such as connected and intelligence devices the core factors. This research focuses on designing new and customized process of technology planning via application of Technology Roadmapping methodology to design Product-Service Systems. In order to verify the model, a complex product-service system which includes interconnected devices (internet of things) with artificial intelligence enabled capabilities is strategically planned by the proposed model.**

## I. Introduction

The Product-Service Systems inherently introduce high level of complexity to long term planning processes and contemplating the customer experience requirements as one of the influential factors in this process, strategic planners need novel tools to manage the level of complexity and also enable them to communicate their process as well as the outcomes with the whole organization.

Any customer value can be defined as a sum of product value and service value. The percentage of service value to total customer value is growing. [1] This creates a complexity for the organizations that provide these services and the organizations that develop the products. The two must be aligned in order to deliver customer value. This co-dependency and integration is critical in emerging technology development. [2][3][4][5]

In this decade the companies are challenged by their competitors not only by the products but also by their capability in delivering solid and robust the services. The designers and strategists of Product-Service Systems (PSS) dive into the ecosystem of the products with inherently embedded services which exponentially increase the complexity of such systems. In most designs the Products get the center piece and Services are subsided and not efficiently designed or integrated. [6]

According to [7] the PSSs are mostly suffer from two perspective 1) the customer value and product functionality doesn't fit together 2) the process of design of products and services are performed in silos by different departments which deteriorates the final integrated outcome.

Many publications state clearly that both Product and Service designs need to start in early stages of the projects and in an integrated manner so that a true Product-Service solution can be delivered to customer.[8], [9]

[10] reviews the benefits of Product-Service system as well as barriers that currently exist to fully adoption of it. The high dependency of customer to the supplier makes it harder for competitors to challenge the solutions. The customers don't need to own the assets to have access to the products or Services. New Services bring about more revenue for businesses and finally PSSs create business sources more sustainable

On the other hand, there should a mutual trust between customer and supplier to covert from transactional basis relationship to a long-term partnership and companies don't have all the required expertise for designing value-packed product-Service Solutions. [10]

## II. Literature Review

### A. An overview of Product-Service Systems

Most of the tools and methodologies that are designed for PSS development are typically using the traditional processes and structures and do not evaluate the actual performance of the outcomes in practice. [11][12][13][14] The process of value delivery doesn't end when the product starts and supplier need to support the customer until end of use or life cycle of product with providing further Services. Contrastingly, the engineering processes are mostly focused on the early phases of the product/Service life cycles and there is not much focus on the mid and end of life cycle phases of a PSS. [9][15][16][17][18]–[20]

Most methodologies that are proposed by the academia for designing PSS emphasize the importance of development of the services but are unsuccessful in embedding them in

978-1-890843-39-7 

business models, strategies and operations of the companies. [21], [22]

Compared to physical products, services are generally under- designed and inefficiently developed [21]. Behara and Chase [22] state that ‘‘if we designed cars the way we seem to design services, they would probably come with one axle and five wheels’’. Most publications emphasize the importance of the development of services, but they fail to provide specific assistance on how to embed these services into the strategic and operative management of enterprises.[21], [22]

Most of the engineering processes don't have clear customer experience management phase in their process steps. [11] suggests a process model for development of the Product-System systems which considers theoretical and empirical aspects of design efforts at the same time.

[23] by means of a multiple case study investigation, provide some guidelines for selecting the most suitable engineering process model for a PSS. [24] Manufacturing companies are getting more interested in the role of services in their business success

From 1980's that the [24] introduced the servitization concepts, the research has grown steadily which brought to light new topics and research gaps in this field in the last four decades.

[25] categorizes the services to three main groups. Base group consist of all services that is provided for the sold goods and products. Intermediate level group of services include the contact center and helpdesks which may include maintenance and repair of the products as well. Finally the advanced services which service provider provides turnkey services in an agreed level of service (SLA) and fully take responsibilities of keep the performance of the products and services of the customer in a certain level.

The manufacturers adopt servitization for different reasons, but mostly it is because of creating new revenue and profit streams [26] Other purposes for embracing the servitization include setting barriers for competitors [27], more involvement and loyalty of customer [23] innovation and novelty in products [26]and betterment in responding to the customer needs and requirements [28]

The other categorization comes from the [29] which break the services into defensive and offensive. The defensive motivation for the servitization includes cost reduction and creating barriers from infiltration of the competitors and offensive incentives are business growth and new revenue streams.

There are numerous critical success factors in servitization. Better understanding of the customer behavior and requirements, acceptance and adoption of the new services by customers, understanding and deploying the dynamics of the value proposition and deep involvement of broader networks in creating the processes. [30]

From the changes that should happen in the processes in the firms to empower them to embrace the servitization there are few considerations. For designing new strategies and capabilities there are two main perspectives; resource-based and dynamic-capabilities. The efforts in these approaches are to find the resources and capabilities that enable Service development and utilization. [31]

### *B. An overview of Technology Roadmapping*

Technology Roadmapping (TRM) is commonly utilized as a flexible and powerful tool for performing strategic and long-term planning in industry. This is graphical method which provides the structure, process and presentation means for illustrating the relationship between Market, Products and technologies over time. [27]

TRM enables the teams to explore and communicate the dynamic relationships between technological resources, organizational objectives and the changing environment. [32] While some companies choose to use this method for particular situations on a one-off basis, others have taken roadmapping forward to form a significant part of their strategy and planning processes. Technology Roadmapping is powerful and meanwhile flexible tool for capturing the input from all subject matter experts (SMEs) and enables the teams to communicate and explore all the alternative of the future plans.[33]

Roadmapping can become the focal, integrating device for carrying the business strategy and planning process forward, bringing together market/commercial and technological knowledge from inside and outside the organization. The planning phase is the most important consideration for customizing the roadmap and roadmapping process, to clearly articulate the business and process objectives and to think through how the generic process of roadmapping might help to achieve the objectives, given the particular situation and context. [34] The generic roadmap is a time-based chart, comprising a number of layers that typically include both commercial and technological perspectives. The roadmap enables the evolution of markets, products and technologies to be explored, together with the linkages and discontinuities between the various perspectives.[35]

Few efforts have been performed to capture the Service as a separate layer in the technology roadmapping diagram[36].

Many organizations has adopted the roadmaps for different purposes ranging from strategic goal setting to technology planning for a future product, therefore roadmapping can refer to many related techniques and approaches. [37]The most important step in designing the roadmap is the planning phase which start before any efforts in starting the actual process of drawing the roadmaps. In this stage, the business and process objectives are clearly articulated and the steps in designing the final roadmap are outlined. [38]

The generic roadmap includes multiple layers for capturing both commercial and technological aspects of the strategic planning and links all the layers through a time-based diagram which illustrate the evolution of the products, services, markets and technologies for achieving the ultimate business goals. [39]

In order to develop roadmap different experts from different fields are involved. [40] emphasizes this concept by referring them as multi-disciplinary and cross-

functional teams. The objective of roadmaps is to provide a direction for future alignment of activities and planning and it is often emphasized that the process of developing the roadmap helps to uncover barriers and baseline on learning and the process itself is often more valuable than the graphical end-product of the actual TRM. There is not really a standard definition of roadmapping or the techniques used to construct roadmaps [40]

Each roadmap creation effort can be unique as the process and objective of roadmapping differ according to goals, product and service variety and the resources available to create the roadmap. Although the purpose and result of the roadmaps are different but most of the experts in roadmapping field agree that it is an effort in the corporate or industry level. [41], [42]

The technology roadmap itself is the document created through a chain of activities in a pre-defined process. It identifies alternate technology ways for meeting certain objectives. From the roadmap a path or paths are selected based on the level of uncertainty. The value in roadmapping is in the discovery and consensus building and not necessarily the final product. [42]

Roadmaps can be technology driven or needs driven but the most successful roadmapping efforts integrate the "technology push" and the "market pull" perspectives. [36]

Roadmaps can also take a retrospective approach or a prospective approach depending on the objective[42], [43]. Lee and Park have provided a guideline for customizing roadmaps to meet specific purposes[44]. Roadmaps start with a need and not a solution. The roadmap process provides away to identify, evaluate and select alternative that can be used to satisfy the need. Different perspectives can be used to develop technology roadmaps[45].

Tops-down start with the definition of the top-level scenario and fill in the lower-level requirements. On the other hand, bottoms-up starts at the technology level and looks at technologies behind developed to identify potential markets or scenarios. Science-driven approaches have also been used that start with current research activities to assess opportunities and 'white spaces' within roadmaps [46]. Technology roadmapping (TRM) provides a framework and links business directly to technology but each organization requires customizing it based on their needs and strategies. [32][47]

### *C. Customer Experience Requirements*

From the brick and mortar stores to online shopping and social network reviews, the customers interact with the firms through numerous channels. The customer journey begins even before they enter the local store or log on the shopping website which is a massive change for the companies to adopt with. These changes require the firms to take new initiative to capture, analyze and deploy the customer requirements and needs and provide them with proper solution which in most case is the result of merging different business units and even the external partners.[48]

The integration of the business functions includes but not limited to marketing, human resources, logistics, IT, service operations and would also involve the external providers and partners. All these efforts are undertaken for design, creation and delivery of positive customer experience. Therefore, the level of complexity for the firms to contain all these changes has increased tremendously [49][50] and they need new tools and processes to adopt this enormous change. The main focus of the researchers has been on identification of the customer-company touch points and measurement of experience that is delivered to them through each of these channels. [51][52][53] And not much empirical work exists in the literature which directly address the customer experience and customer journey. [48]

Schmitt et al. [51] state that every interaction between customer and firm regarding the services result in new customer experiences. This is a very broad definition which includes any customer experience regardless of their nature and it includes all the cognitive, emotional, sensory, social and spiritual responses to interaction between customer and company. [53][54][55]

In almost similar grouping, Schmitt categorizes the customer experiences into sensory (sense), affective (feel), cognitive (think), physical (act), and social-identity (relate) experiences[56].

Verhoef et al. [53] define customer experience as a holistic nature which involve all cognitive, affective, emotional, social and physical experiences of the customer in response to retailer services and products.

Brand experience is studies in another research by Brakus et al. [51] which is viewed as a subjective and internal response of the customer to the firms stimuli. The responses include all the sensations, feelings, cognitions and behavioral reactions to the brand design. McCarthy et al. [57] suggest four categories of sensual, emotional, compositional and spatiotemporal as "four threads of experience" which let us to conceptualize the technology as experience.

Table below present the evolution of the research focus during the last five decades.

| Time Period | 1960s–1970s | 1970s | 1980s | 1990s | 2000s | 2000s–2010s | 2010s |
|---|---|---|---|---|---|---|---|
| Research Focus | Customer buying behavior: process models | loyalty | Service quality | Relationship marketing | Customer relationship management | Customer centricity and customer focus | Customer engagement |
| Research Area | • Encompassed path to purchase<br>• Broad, experiential focus<br>• Conceptual linkage models<br>• Considered customer experience and customer decision making as a process | • Identified key metrics to begin to assess overall customer<br>• Empirical linkage models to identify key drivers<br>• Assessed and evaluated customer perceptions and attitudes about an experience | • Incorporated atmospherics and environment<br>• Early journey mapping through blueprinting<br>• Linked marketing and operations—focus on quality<br>• Identified the specific context and elements of the customer experience | • Expanded to B2B contexts<br>• Identified key attitudinal drivers<br>• Broadened the scope of customer responses considered in the customer experience | • Enabled return-on-investment assessment<br>• Identification of key touch points and drivers<br>• Data driven<br>• Incorporated multichannel aspects<br>• Identified how specific elements of the customer experience influence each other | • Customer perspective throughout organization<br>• Embedded the customer and customer data deeper into the organization<br>• Focused on redesigning customer experience from customer perspective | • Recognized value of nonpurchase interactions<br>• Incorporated positive and negative attitudes, emotions, and behaviors<br>• Conceptual platform to incorporate social media<br>• More clearly recognized the customer's role in the experience |

Figure 1: Customer Experience Research Focus Trends (last 50 years)

The customer experience researches evolved in the last 50 years and the focus of the studies and contributions to customer experience has change tremendously. Lemon et al. [48] identifies the subsequent developments in and contributions to customer experience in 6 era.

*1960s&1970s* - Initial steps in customer experience and purchase decision making

*1970s* - Assessment of customer satisfaction and loyalty

*1980s* - Designing customer journey and Service quality initiatives

*1990s* -Relationship marketing and expanding the customer experience concepts

*2000s* - Customer relationship management and impact of business outcomes

*2000s-2010s* - Business functions integration for delivering positive customer experience

*2010-present* - Customer engagement and recognizing its role in the experience

Some researchers focus on the customer experiences with technology [57] and some others research on brand aspect of the offerings [51] but overall there is there is consensus in the academia and industry that customer experience is a multidimensional concept that involves cognitive, emotional, behavioral, sensorial and social components. [56][53]

## III. LITERATURE GAPS

Most publications emphasize the importance of the development of services, but they fail to provide specific assistance on how to embed these services into the strategic and operative management of enterprises. [58] The development of the strategies and operational process which have the Service as the core is not addressed in most of the publications and they mostly just illustrate the purpose and importance of Service Development.

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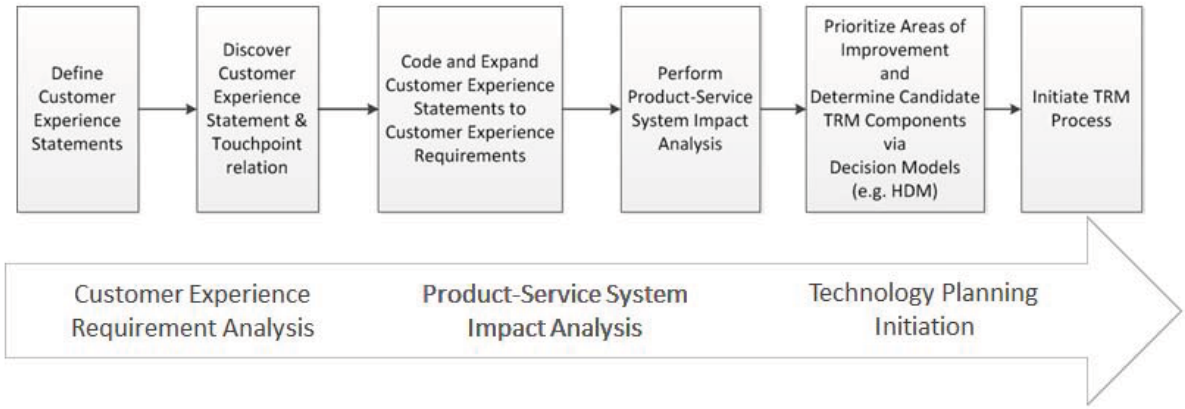
In most of the research initiatives Service Marketing got all the attention and Service Engineering which focuses on know-how of designing and implementing new services which utilize the systemic and methodological approach in Product-Service Systems still requires further studies and researches. [59]

The research shows [23], [60], [61] that for adoption of service strategy, plenty of improvement opportunities exist and there is considerable gap for linking the servitization to strategic decision making in companies. [62] In addition, [31] identified opportunities for decision support systems that facilitate the capability recognition and servitization.

The servitization processes are still in research frontiers and analysis suggests that there are gaps in the academic papers both on how change has occurred and how the manufacturing companies can deploy servitization approaches.[27]

Few efforts have been made in order to research the barriers of changes in manufacturing companies for Servitization adoption but very few researches examine the differences between general changes and required changes in processes for servitization and consider the dynamics this particular field. [28] Models have been introduced that integrated services with the standard technology roadmap process but a systemic way to develop that roadmap is required in order to analyze “bottoms-up” research activities as well as “tops down” market and business drivers and identify where gaps exist. [36]

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## IV. Proposed Model

In order to cover the gap in the literature, author propose few tools that let the roadmapping team to analyze servitization and customer experience component and find the candidate items to take to into the Technology Roadmapping process. The flowchart on Figure 2 shows the preparation and analysis steps prior to initiation of Technology Roadmapping.

Below each of the use and purpose of tools are explained in detail.

### *A. Define Customer Experience Statements*

These statements outline the emotions that the organizations decide they wanted their customers to feel, sense, think and involve. In order to achieve this step of the process, multi-functional teams are formed and during facilitated session, the draft of statements is generated. The best practice to begin is to provide the team with examples of Customer Experience Statements that prime the thought process and facilitates the smooth involvement of the team. In order to prevent panel from biased involvement and also tunnel thinking, the Customer Experience examples need to be entirely different from what is expected in the industry and sector, hence the team involve more in creative thinking and facilitation process doesn't impact the end result of the statements.

In addition, the statements need to be written from outside-in perspective and from the viewpoint of customer since all the effort is to station the customer as the center of all design efforts

### *B. Discover Customer Experience Statement & Touchpoint relation*

The next step in finding the candidate components in Technology Roadmapping is to understand the channels or touch points that the Customer Experience Statements (CXS) are delivered. This matrix is consisted of two variables:

Touchpoints (e.g. Product, infrastructure, social media, maintenance services, shipping, Retail Store, Online store, Contact Center, etc.)

Customer experience (Sensory, emotional, physical, etc.)

| | CXS 1 | CXS 2 | CXS 3 | CXS 4 | CXS 5 | CXS 6 |
|---|---|---|---|---|---|---|
| Touchpoint 1 | | | X | | | |
| Touchpoint 2 | | X | | | | |
| Touchpoint 3 | | | | X | | |
| Touchpoint 4 | | | | | | X |

By marking X in each of the cells, the analyst specifies that there is relation between touchpoint and customer experience statement. This is preparation step before extracting the requirements and providing the team with initial understanding.about the impacted channels and contact spots which need to considered in strategic planning. Figure 3. illustrate an example tool that helps the team to find the relation between the touchpoints and customer experience statements.

### *C. Code and Expand Customer Experience Statements to Customer Experience Requirements*

The statements defined in first stage is used as guideline and high-level policies that need to be adopted by organizational units in general. The statements may be used for aligning the strategic effort of the organization and develop the culture of the behaviors expected from the staff. However, the statements cannot be directly used directly in designing in products and services. In order words, in order to embed these statements in solutions that customers receive, they need to be translated to requirements. There are various standard tools and practices for requirements generation, gathering and analysis which can be used to translate Customer Experience Statements to Customer Experience Requirements. In this stage holding requirement workshop and brainstorming sessions are highly suggested since the main objective of this step is to generate requirements as much as possible and more requirements will let the strategy team to consider all the TRM candidate components prior to initiating the strategic technology planning

### *D. Perform Product-Service System Impact Analysis*

Developing a comprehensive list of requirements set the stage for taking next step to explore the possible ways of delivering of Customer Requirement by analyzing the impact of each requirement of Product-Service System as a whole. In order to enable the team have a solid visibility toward all the requirements and their impact on Products, Services and touchpoints, each of the requirements need to be mapped to all the impacting aspects of PSS. This a critical step as it defines how much cost, effort, change and etc. is required to fulfil any of the customer experience requirements (CXR). Figures 4 & 5 illustrate two sample tools that can be used show the impact of CXRs.

The first column captures all the requirements that was defined in previous stage and the first row of this matrix outlines PSS features. I1~I6 illustrates the relation between each CXR and PSS feature. For example, I1 shows there is an impact from CXR1 on PSS feature 1.

| | *PSS feature 1* | *PSS feature 2* | *PSS feature 3* | *PSS feature 4* | *PSS feature 5* | *PSS feature 6* |
|---|---|---|---|---|---|---|
| *CXR 1* | *I1* | | | | | |
| *CXR 2* | | *I2* | *I3* | *I4* | *I5* | |
| *CXR 3* | | | *I3* | | | |
| *CXR 4* | | | | | | *I6* |

In order to specify the level of impact and convert to applicable matric, each impact level is specified in below table using three levels of High (H), Medium (M) and Low (L). Each of the elements in this table is an input to the decision making model in the next step and enable the technology planner to find all the candidate components for initiating the technology roadmapping process.

| | *Product* | *Service* |
|---|---|---|
| *I1* | *L* | *L* |
| *I2* | *H* | *M* |
| *I3* | *L* | *L* |
| *I4* | *L* | *L* |
| *I5* | *H* | *H* |
| *I6* | *M* | *M* |

### *E. Prioritize areas of improvement and determine candidate TRM Components*

This is last step before initiating the TRM processes. All the previous steps prepared and elaborated on all the relevant and important information that need to be used in technology roadmapping. In this step, all the requirements, drivers and needs that are gathering in previous stage is prioritized and the final candidate for Technology Roadmapping process is determined. It is recommended to use a Hierarchical Decision Model (HDM) and pairwise comparisons to establish more robust measurements of the importance weights of the roadmap targets.

### *F. Initiate TRM process*

Technology Roadmapping is powerful and meanwhile flexible tool for capturing the input from all subject matter experts (SMEs) and enables the teams to communicate and explore all the alternative of the future plans. The technology

roadmap itself is the document created through a chain of activities in a pre-defined process. It identifies alternate technology ways for meeting certain objectives. In order to develop roadmap different experts from different fields are involved and adopting the right TRM tool and process is critical in this stage. The most important step in designing the roadmap is the planning phase which starts before any efforts in starting the actual process of drawing the roadmaps. In this stage, the business and process objectives are clearly articulated and the steps in designing the final roadmap are outlined. Further studies are required to include Customer Experience Requirements from previous stages in Technology Roadmapping tools and process of product-Service Systems as co-design of all aspects of the solution is critical and each input elements and its impact in long term technology planning goals need to be further outlined.

## V. Conclusion

In this paper, the authors reviewed the literature of three independent field of studies; Product-Service Systems, Customer Experience Requirement management and Technology Roadmapping and proposed a novel method of analysis and preparation of the customer experience for the use in technology planning in the organizational level. The conceptual literature review methodology is used in collecting the information as well as the design of the process tools that are proposed in this article. Most of the articles that being utilized in the literature review focus on three main subjects of customer experience, technology roadmapping and product-service systems. The suggested framework provides an instrument for practitioners to adopt the strategic planning of product-service systems as well as researchers to expand the application of the Technology Roadmaps to designing complex integrated solutions for customers. The authors also demonstrated more detailed tools and processes are required to be designed in order to elaborate all aspects of the proposed model and also deploy the model in different scenarios and use cases to narrow down the application which is the target of future studies.

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